difficulties, the measurements can be made, and that a man of science can, if he will, be as scientific in thinking about human beings and their control by education, as in thinking about any fact of nature."

THE BEST METHODS OF TEACHING BOTANY TO SCHOOL STUDENTS*

It would seem that the title of the present address should read The Method of Teaching Botany, since I should argue that there is only one method deserving mention, namely the experimental. Perhaps I should say that I do not underestimate the value of purely observational processes; but unless these lead up to some sort of experimental trial or test it would seem that such method is inadequate in scientific education. Students of agriculture are concerned chiefly with the behavior of plants rather than with the form of plants. One can scarcely imagine circumstances under which a farmer would find it necessary to describe in technical language the form of a leaf or the structure of a flower. The important thing for him is to know what the functions of the various parts are and how they behave. If he knows this, he may then go further if he will. The inference from this is that our education should aim at cultivating the habit of mind which looks for the exact behavior of plants and is able to sift out the causes of variation in behavior. In the brief time at my disposal, I can do no more than to point out some fundamental ideas underlying the successful application of the method of experimentation.

In the first place, the proper attitude of mind in the teacher is most essential. He must have constantly before his mind the fact that plants are living organisms. To be sure they do not move as do animals and we therefore are sometimes slow to regard them as being as much alive as animals are; and one of the practical difficulties in education is to get our pupils to realize this. If plants are living, then the idea of change constitutes

* From an article by Professor F. E. Lloyd in a report on Agricultural and Industrial Education, Department of Agriculture, Montgomery, Alabama.

the key-note of our thought about them. It is the purpose of experiment to determine how these changes are related to changes in the environment, how the organism adapts itself into the circumstances surrounding it. A science which has to do with such phenomena should be vividly alive itself; its methods should be plastic and should not be hampered by custom or habit. The essential point is to get at the truth, and the way to get at the truth is to observe carefully what goes on in nature, realizing all the time that organic nature is nothing but a complex experiment, or to observe by means of special experiment, consciously undertaken. . . .

Teachers are very frequently overawed by what they assume to be the difficulty of conducting experiments. They very easily give way to fear that it involves too much apparatus and it is assumed too frequently that experimentation involves large expenditures of money for apparatus. Aside, however, from exceedingly abstruse work, a vast amount of good experimentation can be done with very little apparatus, if indeed we may call it that at all. The simplest means frequently answer the purpose as well as elaborate apparatus.

The feeling is frequently entertained also that experimentation is too complex for a young student, that it is altogether too difficult and that therefore the work of young pupils must be confined to pure observation. The answer to this is obvious. The real difficulty of science lies not in the method by which knowledge is gained but by the complexity of materials with which it happens to deal. A successful teacher in this regard is one who can skillfully select the materials and subjects for experimental work. In fact, scientific workers are constantly on the out-look for favorable material, as it is called, that is to say, material which gives the desired result with the greatest ease. For example, we choose the grain of Indian corn for work with pupils because it is large and because the young plant is easily studied for the same reason. We might get the same facts by studying the germination of millet but this would entail the use of a magnifying glass or even a microscope while Indian corn may be studied equally well with the naked eye. If on the other hand, we are

studying the behavior of a plant toward the light, we choose one which responds readily and grows quickly. Here millet would perhaps be better than Indian corn. . . . Knowledge is to us real in precise proportion to our actual contact with the things themselves. The most vivid ideas about plants are gained by experimenting with the plants themselves; not even reading a full account of an experiment will take the place of doing it, however successful or unsuccessful that may be. The teacher can always rest upon one certainty, namely that the experiment always tell the truth. To be sure, it may not come out as we expect, but it comes out exactly as it should. Our business is to know what the conditions are and we find this out sometimes only by means of a so-called insuccessful experiment.

The result of this kind of teaching cannot be over-estimated. An agricultural class made up of thoughtful farmers who are willing to experiment for themselves would mean a very great advance in mental development and in material prosperity. This is one of the great aims of agricultural education, namely to cultivate a critical and inquiring frame of mind. We hardly say too much when we declare that success in this direction will be a measure of the amount and the character of experimental work that is done in our schools.

NEWS ITEMS.

Robert A. Harper, Ph.D., now professor of botany in the University of Wisconsin, is to become Torrey professor of botany at Columbia University; succeeding the late Lucien M. Underwood. He was graduated from Oberlin College in 1886, received the degree of Ph.D. at Bonn in 1896, and after service in Gates College, and secondary schools, became in 1891 professor in Lake Forest University. In 1898 he went to the University of Wisconsion.

Dr. John W. Harshberger, assistant professor of botany at the University of Pennsylvania, whose monumental work on the plant geography of North America has just appeared, has been advanced to professor of botany.